

8.2.10 New NWTP

The 2015 Water Resources Plan by the City includes the future potential to supplement the existing WTP with an additional treatment facility located near the intersection of 21st and Zoo Boulevard; this is referred to as the Northwest Treatment Plant (NWTP). A new treatment facility at a location other than the existing WTP provides redundancy and helps mitigate risk associated with loss of treatment/production, but also carries with it an increased cost of operation to staff, operate, and maintain two WTPs and operational complexities of operating two WTPs during low and moderate demand periods.

The Central Plant is aging and requires major rehabilitation or complete replacement likely in the next 20 years. It is assumed, and likely, that the extent of the Central Plant improvements will not allow uninterrupted treatment service. Therefore, the NWTP is sized for 80 MGD to accommodate necessary Central Plant improvements and provide the level of system-wide treatment redundancy desired by the City. An added inherent benefit of the ability to treat and deliver water to the City's customers from multiple locations lessens the severity of any emergency and/or temporary condition that includes loss of treatment. Implementing the NWTP prior to rehabilitation of the Central Plant places its completion within the next 20 years, based on the age of the Central Plant and its condition as confirmed by City staff.

There are several factors impacting the potential processes for the NWTP. The facility will be required to provide softening in addition to all the typical processes. Softening can be completed by lime softening, the current practice, or reverse osmosis. Reverse osmosis (RO) will also remove other constituents like chlorides; however, RO is a high additional cost to construct and operate and disposal of the brine or concentrate must be thoroughly evaluated for feasibility. For the purposes of this report, it is assumed that chloride treatment, when required, will be handled at a different location, likely in the wellfield, and therefore is not included in the NWTP.

Should the City decide to pursue chloride treatment at the NWTP, the following discussion would apply. If chlorides increase in the EBWF to a concentration where their removal is required, an additional treatment technology for the NWTP is required and must be considered in the design as a future provision. RO is one technology that could be used to reduce chloride concentrations in the EBWF groundwater occurs. Other methods for chloride removal include ion exchange and electrodialysis reversal (EDR), but RO is likely the best alternative for the City. Since permitting a disposal mechanism is a fatal flaw for these technologies, developing an acceptable plan for the disposal of the brine for all three alternatives will be a major aspect of future evaluations.

Chlorides have a Secondary Maximum Contaminant Level (SMCL) of 250 mg/L. Additionally, the City has a more stringent finished water quality goal of 80 mg/L chlorides. This is due to existing customers expecting low chloride concentrations in their water, namely dialysis clinics and other industries. The existing treatment process is not capable of removing chlorides. Since RO treatment is primarily for chloride removal, the NWTP is only required to treat raw water that contains chlorides from the EBWF. The remainder of the raw water can be treated with lime softening and conventional filtration. This is a split-stream treatment approach and can deliver lower capital and operating costs, as opposed to treating the entire raw water supply with RO; however, if the surface water supply is lost, then the City would be in a similar treatment capability situation it has been in the past (or pre-East WTP Improvements project).

Under a groundwater only condition for raw water supply, there must be adequate RO capacity to provide 80 MGD of treated water below the SMCL. From a capacity perspective, this condition does not require 80 MGD of RO treatment. Depending on chloride levels, a portion of the raw water flow can bypass the RO process such that the blended water quality is below the SMCL, thereby reducing the RO treatment capacity. Since the amount of water bypassed and blended is dependent on chloride concentration in the raw water source, a detailed evaluation is required to determine the effective capacity for RO treatment. For the purposes of this report, it is assumed that the average chloride concentration in the EBWF is 300 mg/L based on previous studies and as discussed in Section 8.1.4 of this report. Assuming a desired finished water concentration of 80 mg/L and 80% recovery through the RO process, and an overall plant flow rate of 80 MGD, approximately 60 MGD needs to be treated with RO.

Although RO treatment is capable of removing chlorides, this technology has its challenges, primarily with concentrate disposal. A typical RO system can produce approximately 75 to 80 percent permeate and 20 to 25 percent concentrate but these portions are highly variable depending on upstream processes and raw water quality. Current disposal techniques include deep well injection, river outfall, sanitary sewer treatment, and evaporation; it also requires significant infrastructure for disposal, compliance with regulatory drivers, and permitting. These are all significant factors in determining RO treatment viability.

In conclusion, a study is recommended to evaluate the following items in further detail if different treatment capacity and source water end-goals change and/or for capital and operational opinions of probable cost refinement in greater detail beyond that presented herein:

- Evaluate EBWF data on groundwater levels, particularly in the hydraulic barrier area, and the resulting changes in chloride concentrations in the wells; conduct additional groundwater modeling as necessary;
- Perform a comprehensive review of raw water quality, treatment alternatives and/or eliminate chloride removal options not applicable to the City's raw water constituents;
- Evaluate RO, EDR, and ion exchange alternatives; and
- Select and validate a treatment alternative while considering options for split stream treatment, and concentrate disposal.

8.2.11 Water Treatment Planning and Capital Improvements

Multiple options are evaluated for water treatment planning and capital improvements and are based on triggers for capacity, redundancy, and safety considerations. These three options are detailed below and include the Base Option which addresses near term and long term capacity-driven improvements and Option No's. 1 and 2 which address redundancy-driven improvements:

- Base Option – the year 2018 and 2020 deadline reflects starting on these improvements due to the high level of need:
 - Washwater Process Improvements: increases the washwater pumping capacity, additional piping, and new 3.0 MGD gravity sludge thickener. The trigger for this improvement is capacity and is recommended for completion by 2018.
 - Opinion of probable cost = \$3.3 million.
 - Filter Improvements: includes filter media replacement, filter underdrain replacement, backwash chlorination system, piping, valves, instrumentation, controls, and replacement of 48-inch, 36-inch, and 20-inch butterfly valves. These improvements increase filter capacity to 128 MGD with all filters in service. The trigger for this improvement is capacity and is recommended for completion by 2018.
 - Opinion of probable cost = \$8.2 million.
 - New Vacuum Priming System at Hess HSPS: includes skid-mounted vacuum priming system, control, piping, and valves. The trigger for this improvement is replacement and is recommended for completion by 2018.
 - Opinion of probable cost = \$0.32 million.
 - Hess Reservoir Recirculation System: includes submersible pumps situated in the 9.7 MG and 10.6 MG reservoirs and discharge piping to the 4.3 MG reservoir, demolition, electrical, and miscellaneous structural improvements for top slab modifications. The

trigger for this improvement is water quality and is recommended for completion by 2018.

- Opinion of probable cost is \$0.4 million.
 - OSG for Disinfection: includes a storage building, hypochlorite generation equipment, storage tanks, instrumentation, controls, electrical, piping, and site work for completion by 2020.
 - Opinion of probable cost is \$15.8 million.
- Option No. 1:
 - NWTP: includes raw water storage, supply piping and headworks, clarification and softening, 13.3 MGD of RO, stabilization, filtration, disinfection and other chemical feed, finished water storage and pumping, residuals handling, RO concentrate disposals, and dedicated transmission from the NWTP to Hess Reservoir system. The trigger for this improvement is redundancy and is recommended for completion by 2035.
 - Opinion of probable cost is \$231.2 million.
 - If RO is not required, then \$17.3 million can be deducted from the cost above.
 - If Option 1 is selected, it is in addition to the recommended capital improvements in the Base Option.
- Option No. 2:
 - Northwest WTP (NWTP); includes the same items listed for Option No. 1, except the dedicated transmission is replaced with additional transmission in the distribution system. The trigger for this improvement is redundancy and is recommended for completion by 2035.
 - Opinion of probable cost is \$186.4 million.
 - If RO is not required, then \$17.3 million can be deducted from the cost above.
 - If Option 2 is selected, it is in addition to the recommended capital improvements in the Base Option.

Recommendations for additional studies include the following:

- Sludge thickener capacity;
- Sludge lagoon capacity and long term planning recommendations; and
- NWTP alternative treatment options and evaluation of processes to remove chlorides.

8.3 EXISTING CIPs

As part of this master plan, the City requested projects in their existing CIP be evaluated to determine if they are still needed. The current water treatment facility CIPs are listed below in Table 8.6 and a discussion of the improvements, if they are still needed, and the basis for their need follows.

Table 8.6 – Existing City CIP Listing

CIP	Need Status	Trigger
Chemical Feed Improvement	Yes	Age
Treatment Plant Roof Replacement	Yes	Age
WTP 100% Groundwater	Yes	Redundancy
WRP Cen Bas & Aeration Rack Repair	Yes	Age
WTP CL2 Scrubber	Yes	Age
WTP Control Room	Yes	Age
WTP Filter Rehabilitation	Yes	Age/Capacity
WTP Filter Valve Repair	Yes	Capacity
WTP HVAC Safety System	Yes	Age
WTP Replace East Clarifiers	To be determined by City	
WTP Risk Reduction	To be determined by City	
WTP Roof/Structure Repair	Yes	Age
WTP Update SCADA to Cur Version	Yes	Age

Many of these CIPs are age-based and are not directly tied to plant capacity; however, if they were to fail due to age, they will cause capacity problems; therefore, CIPs with triggers for age should take priority over others. Based on discussions with City staff, recommendations for two existing capital improvements related to the filters match those recommended in this master plan. The City should compare these with the information provided in this report to determine the path forward; these improvements are listed below:

- Water Master Plan CIP: Filter Improvements:
 - Comparable City CIP: WTP Filter Rehabilitation
- Water Master Plan reference: filter valve leaks:
 - Comparable City CIP: WTP Filter Valve Repair, a design-build project was awarded in September 2016 and is included in this report.

8.4 Water Distribution

The hydraulic model is used to determine the need for changes in the pressure zone delineation, size and location of additional pipe and transmission lines, pump stations, and storage for each planning period. Storage is adequate for each planning period based on the maximum day demand projections and

improvements. While the water service area does expand beyond the existing limits in year 2045, there is only marginal increase in the water demand projections compared to the year 2035 of about 1 MGD for maximum day.

Water main projects totaling 12 miles to support future growth in Andover is included in the model, but are not represented as capital improvements in the CIP. These projects are anticipated to be initiated by the developer and funded by Special Assessments or Private Projects improvements as indicated by City staff.

11.3.1 Pumping and Pressure

West Maple pressure zone expands north into future development areas between North 167th Street West and North 151st Street West, and south of West 13th Street North. West Maple pressure zone also extends south between South 151st Street West and South 135th Street West to West 23rd Street South. Flow and pressure contributions from each pump station and pressure control points in the distribution system are summarized in Tables 11.9 and 11.10. The model results for pressure under maximum day and peak hour demand conditions are near acceptable levels to current desired range; note, operational changes associated with the Northeast pressure zone and Northeast Tower are in effect and usage of the Southeast BPS for the East Pressure zone is included in these future system model scenarios, therefore, the existing operating pressure ranges may not apply for comparison purposes under these conditions.

11.3.2 Storage

The storage analysis methodology discussed in Section 6.0 is applied for the 2045 planning period and is based on the maximum day demand and minimum storage requirement for fire and equalization. Results of the storage analysis are listed in Tables 11.11 and 11.12 and indicates a storage surplus of 8.8 MG for the Hess, East, and West Maple pressure zones and a storage surplus of 5.5 MG for the Northeast pressure zone; no additional storage is required in the distribution system.

Under minimum hour demand conditions and/or low flow periods at night, lasting 4 to 5 hours, the distribution system and Hess HSPS is capable of filling Webb Road reservoir, Woodlawn Tower, and Roosevelt Tower. Additionally, the distribution system and new pumps at Webb Road PS serving the Northeast pressure zone have adequate capacity to fill the Northeast Tower during low demand periods.

11.4 NWTP Option 2 Distribution System Improvements

All improvements discussed previously in this Section represent the Base Option for the distribution system. Option No. 1 includes the new NWTP in the year 2035 planning period, but has dedicated treated

water transmission to Hess reservoir system where it is pumped to the distribution system via Hess HSPS; therefore, there are no capital improvements in the distribution system required to support Option No. 1.

Option No. 2 is similar to Option No. 1 with respect to the new NWTP located at 21st and Zoo Boulevard except that treated water is delivered directly to the distribution system. Option No. 2 requires approximately 3.1 miles of 66-inch transmission in the distribution system to deliver 80 MGD from the new NWTP. This transmission main (CIP designation 2035-Hess-Option 2-H-1) parallels the existing 36-inch water main from 21st and Zoo Boulevard southwest and ties into the existing 48-inch transmission main near the intersection of North McLean Boulevard and Central Avenue.

Assuming a grade elevation of approximately 1,323 ft at the NWTP, the hydraulic gradient needed to deliver 80 MGD is approximately 1,528 ft under the maximum day demand. This matches the hydraulic gradient of the 2035 and 2045 planning period results for the Base Option (without the NWTP). The parallel 66-inch transmission main improvement discussed in the previous paragraph is required to maintain this hydraulic gradient.

11.5 Northeast Pressure Zone Operation with Northeast Tower

When the Northeast Tower is placed in service, the Northeast pressure zone will transition from a closed system to an open system and require changes to the operational controls at Webb Road PS. The current mode of operation at Webb Road PS utilizes the VFDs to maintain a constant discharge pressure and/or pressure range at 34th Street and Webb Road under varying rates of flow and utilizes 37th Street BPS in a supplementary role for flow support. When the Northeast Tower is placed in service, the Webb Rd PS pumps should be run at constant speed or constant reduced speed and cycle on and off based on operator pre-set levels in the Northeast Tower.

In open distribution systems, pump stations are commonly sized to deliver maximum day demands and rely on elevated storage to provide peaking demands, or equalization demands, and storage for fire. Equalization storage is typically considered the upper portion of elevated tanks and fire protection is the bottom portion. However, equalization storage for the Northeast pressure zone will be provided by a combination of Webb reservoir and the Northeast Tower and is discussed in further detail at the end of this section.

Model results during peak hour demands of approximately 10.8 MGD indicate a drafting rate of approximately 1,400 gpm from Northeast Tower and is equivalent to a volume 84,000 gallons. The storage volume for equalization also represents approximately 3.5 ft within the 40 ft head range of the

14.0 CAPITAL IMPROVEMENTS PLAN

Opinions of probable cost for capital improvements previously discussed are provided in this section of the report. Costs opinions are organized by planning period, classification, size, and pressure zone where applicable. Capital improvement classifications, or triggers, for linear projects include hydraulic, growth (development driven), fire, and redundancy; linear projects are recommended for the raw water and water distribution systems. Hydraulic improvements have a higher priority because they are required to support the demand projections and associated distribution system hydraulics; there is no prioritization for future growth improvements which should be implemented when and where development is occurring. Fire flow improvements can be implemented as funding is available and prior to the planning period it is recommended in. Raw water linear improvements are redundancy driven to improve the reliability of the system and should ultimately be scheduled based on recommended condition assessments of the four major raw water transmission mains.

Capital improvement classifications, or triggers, for vertical projects include capacity, replacement, redundancy, and regulatory. Capacity and regulatory based improvements have the highest priority as they are required for compliance and to support the demand projections; replacement driven improvements have a lower priority because the City has continued to successfully manage the system despite their limitations (i.e. functionality, partial use, regulatory, etc.), but are still required to improve operations. Redundancy driven improvements can be implemented at the City's discretion.

14.1 Cost Estimating Procedures

These order-of-magnitude cost opinions prepared by Burns & McDonnell relating to costs, quantities, demand or pricing (including, but not limited to, property costs, construction, operations or maintenance costs, and/or energy or commodity demand and pricing), are opinions based on Burns & McDonnell's experience, qualifications, judgment, and information from vendors and published sources such as Means. Burns & McDonnell has no control over weather, cost and availability of labor, material and equipment, labor productivity, construction contractor's means and methods, unavoidable delays, construction contractor's method of pricing, demand or usage, population demographics, market conditions, changes in technology, government regulations and laws, and other economic or political factors affecting such opinions. The City of Wichita acknowledges that actual results may vary significantly from the representations and opinions herein, and nothing herein shall be construed as a guarantee or warranty of conclusions, results, or cost opinions. Burns & McDonnell makes no guarantee or warranty (actual or implied) that actual rates, demand, pricing, costs, performance, schedules, quantities, technology, and related items will not vary from the opinions contained in the estimates,

projections, results, or other statements or opinions prepared by Burns & McDonnell. The construction cost index for Kansas City, August 2016, is 11371.00.

14.2 Unit Cost Development for Linear Distribution System Improvements

Unit cost information for linear capital improvements in the water distribution system are based on a collection of over 50 recent water main projects since 2014 for the City of Wichita. The unit cost per diameter (inch)*linear feet for pipe improvements within City limits are estimated at \$9.35/diameter*inch and includes pavement removal and replacement. A unit cost of \$4.50 per diameter (inch)*linear feet is applied to improvements beyond existing City limits and assumes no pavement removal or replacement; these are primarily classified as growth related improvements. Typical water main construction items used in the unit cost development are detailed in Table 14.1 below:

Table 14.1 Water Main Construction Items

Basic Water Main Components	Pavement Replacement	Miscellaneous	Other Potential Items
Pipe	Pavement Repair	Service Connects	Vaults
Valves	Curb and Gutter	Service Lines	Boring
Fittings	Driveway	Pressure Testing	Casing Pipe
Fire Hydrants	Traffic Control	Disinfection	Directional Drilling
Excavation	Demolition	Seeding	Tree Removal
Blow Off Assemblies	Haul Off	Erosion Control	Rock Excavation
		Site Restoration	

14.3 Opinions of Probable Cost

Cost opinions are provided for capital improvements in today's dollars for the raw water, water treatment, and distribution systems. There are three capital improvement plan options and include the Base Option, Option No. 1, and Option No. 2; the cost opinions for Option Nos. 1 and 2 are additive to the Base Option. The Base Option does not include a new WTP and Option Nos. 1 and 2 include the new NWTP, but with different treated water delivery mechanisms. The opinions of probable cost for each option is grouped as follows and summarized in Tables 14.2, 14.3, and 14.4:

- Base Option (stand-alone) = \$387 million
- Base Option plus Option No. 1 = \$618 million
 - Option No. 1 has dedicated treated water transmission from the NWTP to Hess Reservoir system for distribution.
- Base Option plus Option No. 2 = \$599 million

Table 14.2
Cost Opinion Summary: Base Option

System	2017	2018	2020	2025	2030	2035	2045	System Subtotal
Distribution	\$123,000	--	\$8,610,000	--	--	\$1,560,000	\$30,040,000	\$40,300,000
Treatment	--	\$12,150,000	\$15,810,000	--	--	--	--	\$28,000,000
Raw Water ¹	--	\$3,200,000	--	\$163,290,000	\$151,790,000	--	--	\$318,300,000
Planning Period Subtotal	\$123,000	\$15,350,000	\$24,420,000	\$163,290,000	\$151,790,000	\$1,560,000	\$30,040,000	--
Total (all systems & all planning periods)								\$386,600,000

Notes:

1. Trigger year for raw linear improvements portion of the capital cost summary is contingent upon a condition assessment; years 2025 and 2030 are placeholders.

Table 14.3
Cost Opinion Summary: Base Option with Option No. 1

System	2017	2018	2020	2025	2030	2035	2045	System Subtotal
Distribution	\$123,000	--	\$8,610,000	--	--	\$1,560,000	\$30,040,000	\$40,300,000
Treatment	--	\$12,150,000	\$15,810,000	--	--	\$231,200,000	--	\$259,200,000
Raw Water ¹	--	\$3,200,000	--	\$163,290,000	\$151,790,000	--	--	\$318,300,000
Planning Period Subtotal	\$123,000	\$15,350,000	\$24,420,000	\$163,290,000	\$151,790,000	\$232,760,000	\$30,040,000	--
Total (all systems & all planning periods)								\$617,800,000

Notes:

1. Trigger year for raw linear improvements portion of the capital cost summary is contingent upon a condition assessment; years 2025 and 2030 are placeholders.

Table 14.4
Cost Opinion Summary: Base Option with Option No. 2

System	2017	2018	2020	2025	2030	2035	2045	System Subtotal
Distribution	\$123,000	--	\$8,610,000	--	--	\$27,230,000	\$30,040,000	\$66,000,000
Treatment	--	\$12,150,000	\$15,810,000	--	--	\$186,370,000	--	\$214,300,000
Raw Water ¹	--	\$3,200,000	--	\$163,290,000	\$151,790,000	--	--	\$318,300,000
Planning Period Subtotal	\$123,000	\$15,350,000	\$24,420,000	\$163,290,000	\$151,790,000	\$213,600,000	\$30,040,000	--
Total (all systems & all planning periods)								\$598,600,000

Notes:

1. Trigger year for raw linear improvements portion of the capital cost summary is contingent upon a condition assessment; years 2025 and 2030 are placeholders.

- Option No. 2 has direct service to Hess pressure zone from the NWTP and associated transmission improvements to support this in the distribution system.

14.3.1 Base Option

The Base Option includes capital improvements for raw water, treatment, and distribution system improvements. A comprehensive listing for each improvement is listed in Table 14.5 and 14.6 for raw water, Table 14.7 for water treatment, and Tables 14.8 and 14.9 for distribution system improvements. Capital cost summaries for each system are listed below by classification/trigger:

- Raw Water System Improvements:
 - 2018/2019 Vertical
 - Hydraulic = \$3.2 million
 - 2022 Vertical
 - Redundancy/Capacity = \$72.2 million
 - Linear – trigger year to be determined based on condition assessment; placeholder years of 2025 and 2030 are used for EBWF and Cheney transmission respectively.
 - Redundancy = \$242.9 million
- Water Treatment Improvements:
 - 2018 Vertical
 - Capacity = \$11.4 million
 - Replacement = \$0.3 million
 - Water Quality = \$0.4 million
 - 2020 Vertical
 - On-site Sodium Hypochlorite Generation = \$15.8 million (the existing system has always been KDHE approved, but if constructed today the existing system would be out of compliance with current codes. Therefore, the trigger for this improvement could be future regulatory and/or safety if the grandfathered-compliance status changes in the future.
- Distribution System Improvements:
 - 2017 Linear
 - Hydraulic = \$123,000
 - 2020 Linear
 - Hydraulic = \$6.8 million
 - Future = \$400,000

Table 14.5
Raw Water Vertical Improvements - Opinions of Probable Construction Cost: Base Option

CIP Designation ¹	Trigger	Planning Start Year	Unit	Capital Cost Components			
				Construction	Contingency ²	Design ³	Capital Cost Opinion ⁴
2018 Capital Improvements							
2018-Pressure Control Building-H-1	Hydraulic	2017	LS	\$2,000,000	\$800,000	\$400,000	\$3,200,000
2025 Capital Improvements							
2020-Bank Storage Wells-RC-1	Redundancy/Capacity	2017	LS	\$7,720,000	\$3,090,000	\$1,550,000	\$12,400,000
2022-Recharge Recovery Wells-RC-2	Redundancy/Capacity	2019	LS	\$35,260,000	\$14,110,000	\$7,060,000	\$56,430,000
2022-Recharge Basins-RC-3	Redundancy/Capacity	2019	LS	\$2,090,000	\$840,000	\$420,000	\$3,350,000
Subtotal 2025 Capital Cost Opinion							\$75,380,000

Notes:

1. CIP Designation definition = CIP Year-Name-Trigger-Sequential Numbering
Trigger: C = Capacity; R = Redundancy; or RC for both.
2. Contingency at 40 percent of the construction cost.
3. Design at 20 percent of the construction cost.
4. Capital cost opinion includes construction, contingency, and design components.

Table 14.6
Raw Water Linear Improvements - Opinions of Probable Construction Cost: Base Option

Year (TBD) Capital Improvements							
CIP Designation ¹	Trigger	Planning Start Year ⁵	Unit	Capital Cost Components			
				Construction	Contingency ²	Design ³	Capital Cost Opinion ⁴
TBD-EBWF 66" Transmission-R-1	Redundancy	TBD	LS	\$56,940,000	\$22,780,000	\$11,390,000	\$91,110,000
Subtotal Capital Cost Opinion							\$91,110,000
Year (TBD) Capital Improvements							
TBD-60" & 66"Cheney Transmission-R-2	Redundancy	TBD	LS	\$94,860,000	\$37,950,000	\$18,980,000	\$151,790,000
Subtotal Capital Cost Opinion							\$151,790,000

Notes:

1. CIP Designation definition = CIP Year-Name-Trigger-Sequential Numbering
Trigger: C = Capacity; R = Redundancy; or RC for both.
2. Contingency at 40 percent of the construction cost.
3. Design at 20 percent of the construction cost.
4. Capital cost opinion includes construction, contingency, and design components.
5. Planning start year and completion year to be determined based on condition assessment and remaining useful life; placeholder in 2025 for EBWF transmission and in 2030 for Cheney transmission.

Table 14.7
Water Treatment Vertical Improvements - Opinions of Probable Construction Cost: Base Option

2018 Capital Improvements							
CIP Designation¹	Trigger	Planning Start Year	Unit	Capital Cost Components			
				Construction	Contingency²	Design³	Capital Cost Opinion⁴
2018-Washwater Process Improvements-C-2	Capacity	2017	LS	\$2,250,000	\$680,000	\$340,000	\$3,270,000
2018-Filter Improvements-C-4	Capacity	2017	LS	\$5,630,000	\$1,690,000	\$850,000	\$8,170,000
2018-VPS Hess HSPS-RR-1	Replacement	2017	LS	\$220,000	\$70,000	\$30,000	\$320,000
2018-Hess Reservoir Recirculation-WQ-1	Water Qaulity	2017	LS	\$239,000	\$100,000	\$50,000	\$389,000
Subtotal 2018 Capital Cost Opinion							\$12,150,000
2020 Capital Improvements							
2020-On-Site Sodium Hypochlorite Generation-RG-1		2019	LS	\$10,900,000	\$70,000	\$1,640,000	\$15,810,000
Subtotal 2020 Capital Cost Opinion							\$15,810,000

Notes:

1. CIP Designation definition = CIP Year-Name-Trigger-Sequential Numbering
Trigger: C = Capacity; R = Redundancy; RR = Replacement; WQ = water quality.
2. Contingency at 30 percent of the construction cost.
3. Design at 15 percent of the construction cost.
4. Capital cost opinion includes construction, contingency, and design components.
5. Base option does not include a new WTP.

Table 14.8
Distribution System Linear Improvements - Opinions of Probable Construction Cost: Base Option

2017 Capital Improvements											
CIP Designation ¹	Trigger	Model ID	Unit	Water Main Detail			Capital Cost Components				
				Diameter (in)	Quantity	Unit Cost ⁴ (\$/dia-inch*LF)	Planning Start Year	Construction ⁵	Contingency ⁶	Design ⁷	Capital Cost Opinion ⁸
2017-Hess-H-1	Hydraulic	PIPE739	LF	24	344	\$9.35	2017	\$77,100	\$30,800	\$15,400	\$123,000
Subtotal 2017 Capital Cost Opinion											\$123,000
2020 Capital Improvements											
2020-Hess-H-1	Hydraulic	PIPE677	LF	8	70	\$9.35	2019	\$5,200	\$2,100	\$1,000	\$8,300
2020-Hess-H-2	Hydraulic	PIPE705	LF	8	64	\$9.35	2019	\$4,800	\$1,900	\$1,000	\$7,700
2020-Hess-H-3	Hydraulic	PIPE719	LF	8	165	\$9.35	2019	\$12,300	\$4,900	\$2,500	\$19,700
2020-Hess-H-4	Hydraulic	PIPE667	LF	12	58	\$9.35	2019	\$6,500	\$2,600	\$1,300	\$10,400
2020-Hess-H-5	Hydraulic	PIPE713	LF	12	149	\$9.35	2019	\$16,700	\$6,700	\$3,300	\$26,700
2020-Hess-H-6	Hydraulic	PIPE715	LF	12	80	\$9.35	2019	\$9,000	\$3,600	\$1,800	\$14,400
2020-Hess-H-7	Hydraulic	PIPE671	LF	16	100	\$9.35	2019	\$14,900	\$6,000	\$3,000	\$23,900
2020-Hess-H-8	Hydraulic	PIPE717	LF	16	174	\$9.35	2019	\$26,100	\$10,400	\$5,200	\$41,700
2020-Hess-H-9	Hydraulic	PIPE679	LF	24	19	\$9.35	2019	\$4,200	\$1,700	\$1,000	\$6,900
2020-Hess-H-10	Hydraulic	PIPE683	LF	24	97	\$9.35	2019	\$21,700	\$8,700	\$4,300	\$34,700
2020-Hess-H-12	Hydraulic	PIPE691	LF	30	2,883	\$9.35	2017	\$808,700	\$323,500	\$161,700	\$1,293,900
2020-Hess-H-13	Hydraulic	PIPE669	LF	36	53	\$9.35	2019	\$17,700	\$7,100	\$3,500	\$28,300
2020-Hess-H-14	Hydraulic	PIPE787	LF	8	115	\$9.35	2019	\$8,600	\$3,400	\$1,700	\$13,700
2020-Hess-H-15	Hydraulic	PIPE663	LF	30	5,173	\$9.35	2017	\$1,451,000	\$580,400	\$290,200	\$2,321,600
2020-Hess-H-16	Hydraulic	PIPE851	LF	48	996	\$9.35	2017	\$447,000	\$178,800	\$89,400	\$715,200
2020-Hess-H-18	Hydraulic	PIPE637	LF	12	4,456	\$4.50	2017	\$240,600	\$96,200	\$48,100	\$384,900
2020-Hess-H-19	Hydraulic	PIPE641	LF	12	2,848	\$4.50	2017	\$153,800	\$61,500	\$30,800	\$246,100
2020-Hess-G-20	Growth	PIPE591	LF	24	2,307	\$4.50	2020	\$249,200	\$99,700	\$49,800	\$398,700
2020-East-H-1	Hydraulic	PIPE681	LF	16	25	\$9.35	2019	\$3,800	\$1,500	\$1,000	\$6,300
2020-East-H-2	Hydraulic	PIPE659	LF	30	3,460	\$9.35	2017	\$970,600	\$388,200	\$194,100	\$1,552,900
2020-Hess-F-1	Fire	PIPE755	LF	8	731	\$9.35	2019	\$54,600	\$21,800	\$10,900	\$87,300
2020-Hess-F-5	Fire	PIPE765	LF	8	1,026	\$9.35	2017	\$76,800	\$30,700	\$15,400	\$122,900
2020-Hess-F-8	Fire	PIPE771	LF	8	592	\$9.35	2019	\$44,300	\$17,700	\$8,900	\$70,900
2020-Hess-F-11	Fire	PIPE577	LF	12	5,241	\$4.50	2017	\$283,000	\$113,200	\$56,600	\$452,800
2020-Hess-F-12	Fire	PIPE579	LF	12	1,613	\$4.50	2017	\$87,100	\$34,800	\$17,400	\$139,300
2020-Hess-F-13	Fire	PIPE581	LF	12	1,661	\$4.50	2017	\$89,700	\$35,900	\$17,900	\$143,500
2020-Hess-F-14	Fire	PIPE583	LF	12	3,612	\$4.50	2017	\$195,000	\$78,000	\$39,000	\$312,000
2020-Hess-F-15	Fire	PIPE775	LF	12	536	\$9.35	2019	\$60,200	\$24,100	\$12,000	\$96,300
2020-Hess-F-18	Fire	PIPE857	LF	8	186	\$9.35	2019	\$13,900	\$5,600	\$2,800	\$22,300
								Subtotal 2020 Capital Cost Opinion		\$8,600,000	
2035 Capital Improvements											
2035-Hess-H-1	Hydraulic	PIPE701	LF	8	15	\$9.35	2034	\$1,100	\$500	\$1,000	\$2,600
2035-Hess-H-2	Hydraulic	PIPE703	LF	8	82	\$9.35	2034	\$6,100	\$2,400	\$1,200	\$9,700
2035-Hess-H-3	Hydraulic	PIPE721	LF	8	163	\$9.35	2034	\$12,200	\$4,900	\$2,400	\$19,500
2035-Hess-H-4	Hydraulic	PIPE665	LF	12	217	\$9.35	2034	\$24,300	\$9,700	\$4,900	\$38,900
2035-Hess-H-6	Hydraulic	PIPE711	LF	12	62	\$9.35	2034	\$7,000	\$2,800	\$1,400	\$11,200
2035-Hess-H-7	Hydraulic	PIPE673	LF	16	48	\$9.35	2034	\$7,100	\$2,800	\$1,400	\$11,300
2035-Hess-H-8	Hydraulic	PIPE697	LF	16	3,781	\$9.35	2032	\$565,600	\$226,200	\$113,100	\$904,900
2035-Hess-H-9	Hydraulic	PIPE725	LF	16	14	\$9.35	2034	\$2,100	\$800	\$1,000	\$3,900
2035-Hess-H-11	Hydraulic	PIPE699	LF	20	163	\$9.35	2034	\$30,400	\$12,200	\$6,100	\$48,700
2035-East-H-1	Hydraulic	PIPE709	LF	12	18	\$9.35	2034	\$2,000	\$800	\$1,000	\$3,800
								Subtotal 2035 Capital Cost Opinion		\$1,050,000	
2045 Capital Improvements											
2045-Hess-G-1	Growth	PIPE495	LF	12	5,436	\$4.50	2042	\$293,500	\$117,400	\$58,700	\$469,600
2045-Hess-G-2	Growth	PIPE497	LF	12	5,229	\$4.50	2042	\$282,400	\$113,000	\$56,500	\$451,900
2045-Hess-G-3	Growth	PIPE499	LF	12	333	\$4.50	2044	\$18,000	\$7,200	\$3,600	\$28,800
2045-Hess-G-5	Growth	PIPE503	LF	12	4,444	\$4.50	2042	\$240,000	\$96,000	\$48,000	\$384,000
2045-Hess-G-6	Growth	PIPE505	LF	12	5,375	\$4.50	2042	\$290,300	\$116,100	\$58,100	\$464,500
2045-Hess-G-7	Growth	PIPE507	LF	12	4,100	\$4.50	2042	\$221,400	\$88,600	\$44,300	\$354,300
2045-Hess-G-8	Growth	PIPE509	LF	12	2,853	\$4.50	2042	\$154,100	\$61,600	\$30,800	\$246,500
2045-Hess-G-9	Growth	PIPE511	LF	12	5,334	\$4.50	2042	\$288,000	\$115,200	\$57,600	\$460,800
2045-Hess-G-10	Growth	PIPE513	LF	12	2,653	\$4.50	2042	\$143,300	\$57,300	\$28,700	\$229,300
2045-Hess-G-11	Growth	PIPE515	LF	12	5,205	\$4.50	2042	\$281,000	\$112,400	\$56,200	\$449,600
2045-Hess-G-12	Growth	PIPE517	LF	12	5,577	\$4.50	2042	\$301,200	\$120,500	\$60,200	\$481,900
2045-Hess-G-13	Growth	PIPE519	LF	8	4,690	\$4.50	2042	\$168,800	\$67,500	\$33,800	\$270,100
2045-Hess-G-14	Growth	PIPE525	LF	12	5,248	\$4.50	2042	\$283,400	\$113,400	\$56,700	\$453,500
2045-Hess-G-15	Growth	PIPE527	LF	12	5,242	\$4.50	2042	\$283,100	\$113,200	\$56,600	\$452,900
2045-Hess-G-16	Growth	PIPE529	LF	12	5,292	\$4.50	2042	\$285,800	\$114,300	\$57,200	\$457,300
2045-Hess-G-17	Growth	PIPE531	LF	12	5,187	\$4.50	2042	\$280,100	\$112,000	\$56,000	\$448,100
2045-Hess-G-18	Growth	PIPE533	LF	12	1,359	\$4.50	2042	\$73,400	\$29,400	\$14,700	\$117,500
2045-Hess-G-19	Growth	PIPE537	LF	12	1,594	\$4.50	2042	\$86,100	\$34,400	\$17,200	\$137,700
2045-Hess-G-21	Growth	PIPE541	LF	16	1,437	\$4.50	2042	\$103,400	\$41,400	\$20,700	\$165,500
2045-Hess-G-22	Growth	PIPE547	LF	12	2,008	\$4.50	2042	\$108,400	\$43,400	\$21,700	\$173,500
2045-Hess-G-23	Growth	PIPE549	LF	12	5,597	\$4.50	2042	\$302,200	\$120,900	\$60,400	\$483,500
2045-Hess-G-24	Growth	PIPE551	LF	12	5,305	\$4.50	2042	\$286,500	\$114,600	\$57,300	\$458,400
2045-Hess-G-25	Growth	PIPE553	LF	12	5,535	\$4.50	2042	\$298,900	\$119,600	\$59,800	\$478,300
2045-Hess-G-26	Growth	PIPE555*	LF	12	5,261	\$4.50	2042	\$284,100	\$113,600	\$56,800	\$454,500
2045-Hess-G-27	Growth	PIPE557	LF	12	5,205	\$4.50	2042	\$281,100	\$112,400	\$56,200	\$449,700
2045-Hess-G-28	Growth	PIPE559*	LF	12	5,035	\$4.50	2042	\$271,900	\$108,800	\$54,400	\$435,100
2045-Hess-G-29	Growth	PIPE561	LF	12	5,296	\$4.50	2042	\$286,000	\$114,400	\$57,200	\$4

Table 14.8
Distribution System Linear Improvements - Opinions of Probable Construction Cost: Base Option

2017 Capital Improvements											
CIP Designation ¹	Trigger	Model ID	Unit	Water Main Detail			Capital Cost Components				
				Diameter (in)	Quantity	Unit Cost ⁴ (\$/dia-inch*LF)	Planning Start Year	Construction ⁵	Contingency ⁶	Design ⁷	Capital Cost Opinion ⁸
2045-East-G-3	Growth	PIPE447	LF	12	4,715	\$4.50	2042	\$254,600	\$101,800	\$50,900	\$407,300
2045-East-G-4	Growth	PIPE449*	LF	12	5,148	\$4.50	2042	\$278,000	\$111,200	\$55,600	\$444,800
2045-East-G-5	Growth	PIPE451*	LF	12	5,289	\$4.50	2042	\$285,600	\$114,200	\$57,100	\$456,900
2045-East-G-6	Growth	PIPE453	LF	12	5,178	\$4.50	2042	\$279,600	\$111,800	\$55,900	\$447,300
2045-East-G-7	Growth	PIPE455*	LF	12	5,241	\$4.50	2042	\$283,000	\$113,200	\$56,600	\$452,800
2045-East-G-8	Growth	PIPE457*	LF	12	5,333	\$4.50	2042	\$288,000	\$115,200	\$57,600	\$460,800
2045-East-G-9	Growth	PIPE459*	LF	12	5,270	\$4.50	2042	\$284,600	\$113,800	\$56,900	\$455,300
2045-East-G-10	Growth	PIPE461*	LF	12	5,309	\$4.50	2042	\$286,700	\$114,700	\$57,300	\$458,700
2045-East-G-13	Growth	PIPE467*	LF	12	5,218	\$4.50	2042	\$281,700	\$112,700	\$56,300	\$450,700
2045-East-G-14	Growth	PIPE473	LF	12	1,045	\$4.50	2044	\$56,400	\$22,600	\$11,300	\$90,300
2045-East-G-15	Growth	PIPE475*	LF	12	5,278	\$4.50	2042	\$285,000	\$114,000	\$57,000	\$456,000
2045-East-G-16	Growth	PIPE477*	LF	12	5,476	\$4.50	2042	\$295,700	\$118,300	\$59,100	\$473,100
2045-East-G-17	Growth	PIPE479	LF	12	2,847	\$4.50	2042	\$153,700	\$61,500	\$30,700	\$245,900
2045-East-G-18	Growth	PIPE481*	LF	12	5,279	\$4.50	2042	\$285,100	\$114,000	\$57,000	\$456,100
2045-East-G-19	Growth	PIPE483	LF	12	2,648	\$4.50	2042	\$143,000	\$57,200	\$28,600	\$228,800
2045-East-G-20	Growth	PIPE485	LF	12	5,373	\$4.50	2042	\$290,200	\$116,100	\$58,000	\$464,300
2045-East-G-21	Growth	PIPE487	LF	12	5,411	\$4.50	2042	\$292,200	\$116,900	\$58,400	\$467,500
2045-East-G-22	Growth	PIPE489	LF	12	2,855	\$4.50	2042	\$154,200	\$61,700	\$30,800	\$246,700
2045-Northeast-G-1	Growth	PIPE493	LF	12	8,997	\$4.50	2042	\$485,900	\$194,400	\$97,200	\$777,500
Subtotal 2045 Growth Capital Cost Opinion											\$30,040,000

- Notes:
1. CIP Designation definition = CIP Year-Pressure Zone-Trigger-Sequential Numbering
Trigger: H = hydraulic (demand-driven); F = fire flow; G = growth (future development)
 2. Fire flow improvements prioritized as funding is available
 3. Growth improvements prioritized as future development occurs.
 4. Future growth areas outside City limits (peripheral growth) does not include pavement removal and replacement; future growth areas inside City limits (infill growth) and a hydraulic and fire flow improvements includes pavement removal and replacement
 5. Construction cost for horizontal improvements (excludes pump improvements) is based on unit cost
 6. Contingency at 40 percent of the construction cost; minimum contingency cost is \$500.
 7. Design at 20 percent of the construction cost; minimum design cost is \$1,000.
 8. Capital cost opinion includes construction, contingency, and design components.
 9. Base conditions do not include a new WTP.
 10. Model IDs with an asterisk (*) represent pipes that extend into neighboring water suppliers or rural water districts where the City has designated some portion therein as a future growth area
 11. Unit cost at \$4.50/dia-inch*LF plus \$800/LF for for horizontal boring.

Table 14.9
Distribution System Vertical Improvements - Opinions of Probable Construction Cost: Base Option

2035 Capital Improvements								
CIP Designation ¹	Trigger	Type	Unit	Planning Start Year	Capital Cost Components			
					Construction	Contingency ²	Design ³	Capital Cost Opinion ⁴
2035-West Maple BPS-H-1	Hydraulic	Pump	LS	2034	\$15,000	\$6,000	\$3,000	\$24,000
2035-SE BPS-H-1	Hydraulic	Pump	LS	2032	\$310,000	\$120,000	\$60,000	\$490,000
Subtotal 2035 Capital Cost Opinion								\$510,000

Notes:

1. CIP Designation definition = CIP Year-Pump Station-Trigger-Sequential Numbering
Trigger: H = hydraulic (demand-driven)
2. Contingency at 40 percent of the construction cost.
3. Design at 20 percent of the construction cost.
4. Capital cost opinion includes construction, contingency, and design components.
5. Base conditions do not include a new WTP.

- Note, this represents CIP 2020-Hess-G-20 and was previously planned for future growth in 2045 but was accelerated to support road paving projects beginning in 2025 as indicated by City staff.
 - Fire = \$1.5 million
- 2035 Linear
 - Hydraulic = \$1.1 million
- 2035 Vertical
 - Hydraulic = \$0.5 million
 - Pump additions at West Maple BPS and Southeast BPS
- 2045 Linear
 - Growth = \$30.0 million

14.3.2 Option No. 1

Option No. 1 includes the new NWTP and dedicated finished water transmission from the site at 21st and Zoo Boulevard to the Hess Reservoir system and is additive to the Base Option improvements. An itemized listing for each improvement is listed in Table 14.10. The capital cost summary is listed below by classification/trigger:

- Water Treatment Improvements
 - 2035 Vertical
 - Redundancy = \$186.4 million (includes 13.3 MGD of RO)
 - If RO is not required, then \$17.3 million can be deducted from the cost above.
 - 2035 Linear
 - Redundancy = \$44.8 million

14.3.3 Option No. 2

Option No. 2 includes the new NWTP with direct service to the distribution system and is additive to the Base Option. An itemized listing for each improvement is listed in Tables 14.11 and 14.12. The capital cost summary is listed below by classification/trigger:

- Water Treatment Improvements:
 - 2035 Vertical
 - Redundancy = \$186.4 million (includes 13.3 MGD of RO)
 - If RO is not required, then \$17.3 million can be deducted from the cost above.
- Distribution System Improvements:
 - 2035 Linear

Table 14.10
Water Treatment Vertical and Linear Improvements - Opinions of Probable Construction Cost: Option 1

2035 Capital Improvements							
CIP Designation ¹	Trigger	Planning Start Year	Unit	Capital Cost Components			
				Construction	Contingency ²	Design ³	Capital Cost Opinion ⁴
2035-Northwest WTP-R-1	Redundancy	2032	LS	\$133,120,000	\$39,940,000	\$13,310,000	\$186,370,000
2035-Finished Water Transmission-R-2	Redundancy	2032	LS	\$28,020,000	\$11,210,000	\$5,600,000	\$44,830,000
Subtotal 2035 Capital Cost Opinion							\$231,200,000

Notes:

1. CIP Designation definition = CIP Year-Name-Trigger-Sequential Numbering
Trigger: R = Redundancy.
2. Contingency at 30 percent of the construction cost for 2035-Northwest WTP-R-1; contingency at 40 percent for 2035-Finished Water Transmission-R2.
3. Design at 10 percent of the construction cost for 2035-Northwest WTP-R-1; design at 20 percent for 2035-Finished Water Transmission-R2.
4. Capital cost opinion includes construction, contingency, and design components.

Table 14.11
Distribution System Linear Improvements - Opinions of Probable Construction Cost: Option 2

2035 Capital Improvements								
CIP Designation ¹	Model ID	Trigger	Planning Start Year	Unit	Capital Cost Components			
					Construction	Contingency ²	Design ³	Capital Cost Opinion ⁴
2035-Hess-Option 2-H-1	PIPE795, PIPE797	Hydraulic	2032	LS	\$16,040,000	\$6,420,000	\$3,210,000	\$25,670,000
Subtotal 2035 Capital Cost Opinion								\$25,670,000

Notes:

1. CIP Designation definition = CIP Year-Pressure Zone-Option-Trigger-Sequential Numbering
Trigger: H = Hydraulic; Option = Option 2
2. Contingency at 40 percent of the construction cost.
3. Design at 20 percent of the construction cost.
4. Capital cost opinion includes construction, contingency, and design components.
5. If Option 2 is selected, then this cost opinion is in addition to the Base Option less the following Base Option capital improvement: 2025-New 80 MGD Filter Gallery-R-1.

Table 14.12
Water Treatment Vertical Improvements - Opinions of Probable Construction Cost: Option 2

2035 Capital Improvements							
CIP Designation ¹	Trigger	Planning Start Year	Unit	Capital Cost Components			
				Construction	Contingency ²	Design ³	Capital Cost Opinion ⁴
2035-Northwest WTP-R-1	Redundancy	2032	LS	\$133,120,000	\$39,940,000	\$13,310,000	\$186,370,000
Subtotal 2035 Capital Cost Opinion							\$186,370,000

Notes:

1. CIP Designation definition = CIP Year-Name-Trigger-Sequential Numbering
Trigger: C = Capacity; R = Redundancy.
2. Contingency at 30 percent of the construction cost.
3. Design at 10 percent of the construction cost.
4. Capital cost opinion includes construction, contingency, and design components.

- Redundancy = \$25.7 million

14.4 Capital Planning Schedule

Capital planning schedules for all linear and vertical improvements are included in Appendix X. Linear improvements include a thumbnail picture for locational orientation in the system and facility location for vertical improvements is described in the CIP designation/name. Vertical improvements include a general itemized listing of the components included in the cost opinion.

14.5 Economic Evaluations

Economic evaluations include a present worth analysis to compare the present value of Option No. 1 and Option No. 2 and determining the operation and maintenance (O&M) cost to produce water for each option. These options include a new NWTP with the following variations:

- Option No. 1 includes dedicated finished water transmission from a new NWTP to the finished water reservoir system at the existing WTP for high service pumping to the distribution system.
- Option No. 2 includes finished water with direct service to the distribution system from a new NWTP.

These options represent the lowest common denominators for the capital improvements plan. The Base Option for raw water and water distribution system capital improvements are recommended regardless of the capital improvements associated with Option No.'s 1 and 2; therefore, they are not included in the economic evaluations. The present worth analysis for both options includes the following components:

- Capital Costs:
 - Beginning in year 2035 and inflated to year 2035 dollars.
 - Option No. 1 includes NWTP and transmission (linear).
 - Option No. 2 includes NWTP and distribution system improvements (linear) required to support direct service.
- Operations and maintenance (O&M) Costs:
 - Beginning in year 2035 and inflated to year 2035 dollars.
 - Pumping energy: Option No. 1 based on the horsepower required to deliver 50 percent of the average day demand to Hess reservoir system. Option No. 2 results in an energy savings because the horsepower required to deliver the total average day demand from two locations is lower than what is required to deliver the total from one location (i.e. existing WTP as is the case with Option No. 1).
 - RO Energy cost for 13.3 MGD of RO treatment.

- Chemical: based on the highest 4-year chemical costs for the existing WTP which occurred in 2015 at \$0.10/1,000 gallons.
- Membrane and cartridge filter replacement: annual replacement cost.
- Wages: based on existing WTP personnel wages in 2015; assumes a similar workforce is required.
- Other variables and assumptions:
 - Inflation: capital costs at 3.5 percent, energy cost at 4.0 percent, equipment replacement and chemical costs at 3.5 percent, and plant personnel wages at 3.0 percent.
 - Interest at 6.0 percent.
 - Energy at \$0.06/KW*hr based on an average of the monthly energy bills for Hess HSPS and Central WTP in 2015.
 - O&M costs for pumping energy, treatment energy, and chemical assumes the NWTP produces 50 percent of the average day demand.
 - Average day demand based on the water demand projections discussed in Section 3.0 throughout the planning period through year 2045.
 - Piping and Pumping:
 - Steel pipe with inner diameter equal to the recommended size, AWWA C200 standards with cement mortar lining.
 - C-value of 110 and minor loss coefficient of 3.
 - Wire-to-water efficiency of 67.5 percent.

The present worth analysis for Option No. 1 is included in Table 14.13 and results in a present value of \$199,500,000. The present worth analysis for Option No. 2 is included in Table 14.14 and results in a present value of \$186,115,000. By the 2045 planning period the O&M cost of water for Option No. 1 and Option No. 2 is \$1.81/1,000 gallons and \$1.77/1,000 gallons respectively and is also listed in Tables 14.13 and 14.14.

14.6 Non-economic Evaluations

Non-economic considerations for redundancy driven improvements associated with the raw water system and water treatment facilities are listed below:

- Raw Water Transmission: TBD(year)-EBWF 66" Transmission-R-1, TBD(year)-Cheney 60" & 66" Transmission-R-2
 - Advantages:

Table 14.13
New Northwest WTP Present Worth Analysis - Option No. 1

Year	Capital Cost ¹		Operation and Maintenance Costs ²							Total Present Value ³	Present Value Cummulation	Average Day Demand ⁴ (MGD)	O&M Cost of Water (\$/1,000 gal)
	Treatment	Transmission	NWTP Transfer Pumping Energy ⁵	RO Energy ⁶	Chemical ⁷	Membrane & Cartridge Filter Replacement	Other Replacement ⁸	Wages ⁹	Total O&M				
	2035-NWTP-R-1	2035-FWT-R-2											
2016			--	--	--	--	--	--	--	--	--	--	--
2017			--	--	--	--	--	--	--	--	--	--	--
2018			--	--	--	--	--	--	--	--	--	--	--
2019			--	--	--	--	--	--	--	--	--	--	--
2020			--	--	--	--	--	--	--	--	--	--	--
2021			--	--	--	--	--	--	--	--	--	--	--
2022			--	--	--	--	--	--	--	--	--	--	--
2023			--	--	--	--	--	--	--	--	--	--	--
2024			--	--	--	--	--	--	--	--	--	--	--
2025			--	--	--	--	--	--	--	--	--	--	--
2026			--	--	--	--	--	--	--	--	--	--	--
2027			--	--	--	--	--	--	--	--	--	--	--
2028			--	--	--	--	--	--	--	--	--	--	--
2029			--	--	--	--	--	--	--	--	--	--	--
2030			--	--	--	--	--	--	--	--	--	--	--
2031			--	--	--	--	--	--	--	--	--	--	--
2032			--	--	--	--	--	--	--	--	--	--	--
2033			--	--	--	--	--	--	--	--	--	--	--
2034			--	--	--	--	--	--	--	--	--	--	--
2035	\$358,297,000	\$86,174,000	\$208,000	\$4,307,000	\$2,467,000	\$0	\$0	\$5,577,000	\$12,559,000	\$151,054,000	\$151,054,000	35.15	\$0.98
2036			\$217,000	\$4,479,000	\$2,556,000	\$1,990,000	\$2,278,000	\$5,745,000	\$17,265,000	\$5,383,000	\$156,437,000	35.19	\$1.34
2037			\$226,000	\$4,658,000	\$2,648,000	\$2,059,000	\$2,358,000	\$5,917,000	\$17,866,000	\$5,255,000	\$161,692,000	35.23	\$1.39
2038			\$235,000	\$4,845,000	\$2,744,000	\$2,132,000	\$2,441,000	\$6,094,000	\$18,491,000	\$5,131,000	\$166,823,000	35.27	\$1.44
2039			\$245,000	\$5,038,000	\$2,843,000	\$2,206,000	\$2,526,000	\$6,277,000	\$19,135,000	\$5,009,000	\$171,832,000	35.31	\$1.48
2040			\$255,000	\$5,240,000	\$2,946,000	\$2,283,000	\$2,614,000	\$6,466,000	\$19,804,000	\$4,891,000	\$176,723,000	35.35	\$1.53
2041			\$266,000	\$5,449,000	\$3,053,000	\$2,363,000	\$2,706,000	\$6,660,000	\$20,497,000	\$4,776,000	\$181,499,000	35.39	\$1.59
2042			\$277,000	\$5,667,000	\$3,163,000	\$2,446,000	\$2,801,000	\$6,859,000	\$21,213,000	\$4,663,000	\$186,162,000	35.43	\$1.64
2043			\$288,000	\$5,894,000	\$3,278,000	\$2,532,000	\$2,899,000	\$7,065,000	\$21,956,000	\$4,553,000	\$190,715,000	35.47	\$1.70
2044			\$300,000	\$6,130,000	\$3,396,000	\$2,620,000	\$3,000,000	\$7,277,000	\$22,723,000	\$4,445,000	\$195,160,000	35.51	\$1.75
2045			\$312,000	\$6,375,000	\$3,519,000	\$2,712,000	\$3,105,000	\$7,495,000	\$23,518,000	\$4,340,000	\$199,500,000	35.55	\$1.81
Totals	\$358,297,000	\$86,174,000	--	--	--	--	--	--	--	\$199,500,000	--	--	--

Notes:

1. Capital cost inflated at 3.5 percent.
2. Energy inflated at 4.0 percent; chemical and equipment replacement inflated at 3.5 percent; plant personnel wages inflated at 3.0 percent
3. Present value with fixed interest at 6.0 percent
4. Average day demand is half of the demand projection; assumes 50 percent of the average day demand is treated by the NWTP and 50% is treated by the existing WTP.
5. Energy costs for water transfer from NWTP to Hess reservoir system for distribution system pumping; this does not represent Hess HSPS energy costs.
6. RO energy for 13.3 MGD of RO treatment.
7. Chemical is based on the highest 4-year chemical costs for the existing WTP which occurred in 2015 at \$0.10/1,000 gallons.
8. Other replacement is estimated at 2 percent of the non-membrane and non-filtration capital cost without markups.
9. Wages are based on inflated 2015 expenditures for existing water treatment and pumping personnel.

Table 14.14
New Northwest WTP Present Worth Analysis - Option No. 2

Year	Capital Cost ¹		Operation and Maintenance Costs ²							Total Present Value ³	Present Value Cummulation	Average Day Demand ⁴ (MGD)	O&M Cost of Water (\$/1,000 gal)
	Treatment	Distribution	Pumping Energy Savings ⁵	RO Energy ⁶	Chemical ⁷	Membrane & Cartridge Filter Replacement	Other Replacement ⁸	Wages ⁹	Total O&M				
	2035-NWTP-R-1	2035-Hess-Option 2-H-1											
2016			--	--	--	--	--	--	--	--	--	--	--
2017			--	--	--	--	--	--	--	--	--	--	--
2018			--	--	--	--	--	--	--	--	--	--	--
2019			--	--	--	--	--	--	--	--	--	--	--
2020			--	--	--	--	--	--	--	--	--	--	--
2021			--	--	--	--	--	--	--	--	--	--	--
2022			--	--	--	--	--	--	--	--	--	--	--
2023			--	--	--	--	--	--	--	--	--	--	--
2024			--	--	--	--	--	--	--	--	--	--	--
2025			--	--	--	--	--	--	--	--	--	--	--
2026			--	--	--	--	--	--	--	--	--	--	--
2027			--	--	--	--	--	--	--	--	--	--	--
2028			--	--	--	--	--	--	--	--	--	--	--
2029			--	--	--	--	--	--	--	--	--	--	--
2030			--	--	--	--	--	--	--	--	--	--	--
2031			--	--	--	--	--	--	--	--	--	--	--
2032			--	--	--	--	--	--	--	--	--	--	--
2033			--	--	--	--	--	--	--	--	--	--	--
2034			--	--	--	--	--	--	--	--	--	--	--
2035	\$358,297,000	\$49,351,000	-\$157,000	\$4,307,000	\$2,467,000	\$0	\$0	\$5,577,000	\$12,194,000	\$138,763,000	\$138,763,000	35.15	\$0.95
2036			-\$163,000	\$4,479,000	\$2,556,000	\$1,990,000	\$2,278,000	\$5,745,000	\$16,885,000	\$5,265,000	\$144,028,000	35.19	\$1.31
2037			-\$170,000	\$4,658,000	\$2,648,000	\$2,059,000	\$2,358,000	\$5,917,000	\$17,470,000	\$5,139,000	\$149,167,000	35.23	\$1.36
2038			-\$177,000	\$4,845,000	\$2,744,000	\$2,132,000	\$2,441,000	\$6,094,000	\$18,079,000	\$5,017,000	\$154,184,000	35.27	\$1.40
2039			-\$184,000	\$5,038,000	\$2,843,000	\$2,206,000	\$2,526,000	\$6,277,000	\$18,706,000	\$4,897,000	\$159,081,000	35.31	\$1.45
2040			-\$192,000	\$5,240,000	\$2,946,000	\$2,283,000	\$2,614,000	\$6,466,000	\$19,357,000	\$4,781,000	\$163,862,000	35.35	\$1.50
2041			-\$200,000	\$5,449,000	\$3,053,000	\$2,363,000	\$2,706,000	\$6,660,000	\$20,031,000	\$4,667,000	\$168,529,000	35.39	\$1.55
2042			-\$208,000	\$5,667,000	\$3,163,000	\$2,446,000	\$2,801,000	\$6,859,000	\$20,728,000	\$4,556,000	\$173,085,000	35.43	\$1.60
2043			-\$216,000	\$5,894,000	\$3,278,000	\$2,532,000	\$2,899,000	\$7,065,000	\$21,452,000	\$4,448,000	\$177,533,000	35.47	\$1.66
2044			-\$225,000	\$6,130,000	\$3,396,000	\$2,620,000	\$3,000,000	\$7,277,000	\$22,198,000	\$4,343,000	\$181,876,000	35.51	\$1.71
2045			-\$235,000	\$6,375,000	\$3,519,000	\$2,712,000	\$3,105,000	\$7,495,000	\$22,971,000	\$4,239,000	\$186,115,000	35.55	\$1.77
Totals	\$358,297,000	\$49,351,000	--	--	--	--	--	--	--	\$186,115,000	--	--	--

Notes:

1. Capital cost inflated at 3.5 percent.
2. Energy inflated at 4.0 percent; chemical and equipment replacement inflated at 3.5 percent; plant personnel wages inflated at 3.0 percent.
3. Present value with fixed interest at 6.0 percent
4. Average day demand is half of the demand projection; assumes 50 percent of the average day demand is treated by the NWTP and 50% is treated by the existing WTP.
5. Pumping the total average day demand from two locations (new NWTP and existing WTP) requires less pressure than pumping the total demand from one location (i.e. Option No. 1).
6. RO energy for 13.3 MGD of RO treatment.
7. Chemical is based on the highest 4-year chemical costs for the existing WTP which occurred in 2015 at \$0.10/1,000 gallons
8. Other replacement is estimated at 2 percent of the non-membrane and non-filtration capital cost without markups
9. Wages are based on inflated 2015 expenditures for existing water treatment and pumping personnel